



TENNESSEE DEPARTMENT OF

EDUCATION
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Structural Systems I

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| Primary Career Cluster: | Architecture & Construction |
| Consultant: | Rachel Allen, (615) 532-2835, Rachel.Allen@tn.gov |
| Course Code(s): | 6164 |
| Prerequisite(s): | <i>Fundamentals of Construction</i> (6073) |
| Credit: | 1 |
| Grade Level: | 10 |
| Graduation Requirements: | This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses. |
| Programs of Study and Sequence: | This is the second course in the <i>Structural Systems</i> program of study. |
| Aligned Student Organization(s): | SkillsUSA: http://site1.tnskillsusa.com/ Brandon Hudson, (615) 532-2804, Brandon.Hudson@tn.gov |
| Coordinating Work-Based Learning: | Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit http://tn.gov/education/cte/work_based_learning.shtml . |
| Available Student Industry Certifications: | Modules may count towards NCCER Carpentry. |
| Dual Credit or Dual Enrollment Opportunities: | There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement. |
| Teacher Endorsement(s): | 522, 575, 580, 592, 706 |
| Required Teacher Certifications/Training: | None |
| Teacher Resources: | http://www.tn.gov/education/cte/ArchitectureConstruction.shtml |

Course Description

Structural Systems I prepares students for careers in residential and commercial carpentry. Upon completion of this course, proficient students will be able to demonstrate knowledge and skill in framing buildings. Students will be able to frame floors, walls, ceilings, roofs, and stairs while safely employing tools and interpreting construction drawings to complete projects. Emphasis is placed on demonstrating proper measurement and application of mathematical concepts. Standards in this course also include principles of the construction industry and business and project management. Students will continue

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compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in this program of study. Standards in this course are aligned with Tennessee State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee State Standards in Mathematics, Tennessee Physical Science Standards, Tennessee Physics Standards, and the National Center for Construction Education and Research (NCCER) Curriculum.*

Program of Study Application

This is the second course in the *Structural Systems* program of study. For more information on the benefits and requirements of implementing these programs in full, please visit the Architecture & Construction website at <http://www.tn.gov/education/cte/ArchitectureConstruction.shtml>.

Course Standards

Safety

- 1) Identify safety hazards on a jobsite and demonstrate practices for safe working. Accurately read, interpret, and demonstrate adherence to safety rules, including but not limited to rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between the rules and explain why certain rules apply. Perform a hazard assessment for a given task such as working on a ladder to install roof framing components. Explain the steps necessary to safely perform the task, outlining steps to take in case of an emergency. (TN Reading 3, 4, 6; TN Writing 2)
- 2) Maintain safety records and demonstrate adherence to industry-standard practices regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Incorporate safety procedures when operating tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete safety test with 100 percent accuracy. (TN Reading 3, 4)
- 3) Follow procedures to work safely around materials. Adhere to responsibilities for employees in material safety as outlined by the Hazard Communication Standard (HazCom), such as locating and interpreting material safety data sheets (MSDS). Demonstrate safe procedures to move materials by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment. (TN Reading 3, 4)

Career Exploration

- 4) Referencing data from U.S. Department of Labor and other sources, explain an apprenticeship. Write persuasively to describe the benefits of the apprenticeship approach of on-the-job training paired with related training for individuals seeking construction careers. Use a variety of sources to gather data, cite each source, and briefly describe why the chosen source is reliable. (TN Reading 1, 7, 8; TN Writing 1, 8)

- 5) Research apprenticeships and postsecondary institutions (colleges of applied technology, community colleges, and four-year universities) in Tennessee and other states that offer construction-related programs. Write an informative paper or develop an infographic identifying entry requirements for a specific apprenticeship or postsecondary program of study, and the secondary courses that will prepare students to be successful in the program. (TN Reading 1; TN Writing 4, 7)

Construction Industry Principles

- 6) Investigate and report on the process for determining the zoning regulations of a building site. Describe how zone designation and regulations such as setbacks, ground coverage, and maximum height impact the design, placement, and use of a building on a given site, citing findings from the investigation. Read and interpret zoning ordinances and other regulations impacting a given site (city, county, historic district, subdivision regulations, etc.). (TN Reading 2, 3, 4; TN Writing 2)
- 7) Explain inspection procedures used to enforce building codes during the construction of a residential or commercial building, outlining the roles and responsibilities of the building inspector and the contractor and the intervals at which inspections are performed. (TN Reading 2, 3, 4)

Types of Structural Systems

- 8) Compare and contrast types of structural framing systems, including wood light-frame, structural steel, and reinforced concrete, analyzing the factors influencing the selection of a structural system for given building functions. Using textbooks, online resources, or examples in the community, select three buildings with different framing types and explain why each type was used for the building's function. (TN Reading 1, 2, 4, 5; TN Writing 2, 9)

Materials and Methods of Light-Frame Wood Construction

- 9) Distinguish among the basic types of wood framing systems, such as platform frames, balloon frames, and post-and-beam frames. Create a chart to define and compare the pros and cons of each type, citing examples of when each is used. (TN Reading 1, 2, 4, 5, 7; TN Writing 2, 9)
- 10) Analyze the characteristics and uses of various types of wood products used in light frame construction.
 - a. Categorize types of wood as hardwood or softwood.
 - b. Identify differences in woods used in interior and exterior applications.
 - c. Identify grades of lumber, common lumber defects, and differences in treated and untreated lumber.
 - d. Explain the difference between actual and nominal lumber sizes.
 - e. Distinguish among the properties and uses of engineered wood products such as plywood, hardboard, particleboard, oriented strand board, mineral fiberboard, glulam lumber, and wood I-beams.

Drawing on resources such as textbooks and wood product retailers' catalogs, examine actual wood product samples and create a written description of each, identifying the type and grade

of the product, noticing and naming any defects, and explaining common uses of the product. (TN Reading 1, 2, 4, 5, 7; TN Writing 2, 9)

Tools & Equipment

- 11) Accurately identify hand and power tools used in carpentry, describing the safe use and maintenance of each. Hand tools include levels, squares, planes, clamps, and hand saws. Power tools include power saws, drill presses, routers, laminate trimmers, portable power planes, power metal shears, and pneumatic and cordless nailers and staplers. For each of the systems covered in this course, identify and select the proper tools and accessories, critique the readiness of the tools, use the tools to accomplish the desired tasks, and then return the tools and accessories to their proper storage. (TN Reading 2, 3, 4)

Construction Drawings & Specifications

- 12) Inspect and interpret a full set of construction drawings and specifications for a construction project including civil, architectural, structural, mechanical, plumbing, electrical, and fire protection drawings and specifications. Read and interpret different drawing types including plan view drawings, elevation view drawings, section drawings, detail drawings, and schedules. Explain the relationship between different types of drawing and the importance of cross-referencing different types of drawings with one another and cross-referencing drawings with specifications. For example, explain how a floor plan, elevation, and detail drawing may all be used to inform the reader about the layout and material of a given building component, such as a cabinet layout or an exterior wall. (TN Reading 1, 2, 4, 5, 6, 7, 9)

Floor Framing Systems

- 13) Implement geometric principles to square a building layout. For example, in the process of staking the corners of a building, check the layout for squareness by using the 3-4-5 rule based on right triangles and the Pythagorean Theorem. (TN Reading 3; TN Math N-Q, G-SRT)
- 14) Identify the components which make up a floor frame, analyzing the purpose of and interrelationships among each component and explaining the sequence in which each is constructed. (TN Reading 2, 3, 4, 5)
- 15) Read and interpret construction drawings to determine floor system requirements, such as the proper girder and joist size for a given span and floor load, and estimate the amount of material needed to frame a floor assembly. (TN Reading 1, 4, 7; TN Math N-Q)
- 16) Describe the procedures necessary to fasten sills to the foundation and construct a floor assembly. Apply the appropriate tools, equipment, and procedures to build a floor assembly. Work in teams to install girders, lay out and install floor joists, install bridging and blocking, and apply subflooring. (TN Reading 3)

Wall and Ceiling Framing Systems

- 17) Explain the procedure to lay out a wood frame wall, defining and describing the components such as plates, studs, partitions, door and window openings, bracing, and other components. (TN Reading 3, 4)
- 18) Read and interpret drawings to determine wall and ceiling frame requirements for a given residential or commercial structure. For example, calculate the length of a stud and estimate the amount of material needed to frame a wall and ceiling assembly. (TN Reading 4; TN Math N-Q)
- 19) Work in teams to construct a wall frame and ceiling assembly by implementing required safety techniques, tools, and equipment. Accurately measure and lay out the frame; accurately level and plumb the walls. (TN Reading 3; TN Math N-Q)

Roof Framing Systems

- 20) Define and describe the framing components of gable and hip roofs such as the ridge board, plates, and types of rafters. Create a graphic illustration showing the roles of each component and how they work together in a roof framing system. (TN Reading 3, 4, 7)
- 21) Read and interpret drawings to determine roof framing requirements, such as calculating the length of a rafter based on the desired pitch and estimating the materials needed to frame and sheath a roof. For example, use a speed square to lay out a common rafter on a piece of lumber. (TN Reading 2, 3, 4; TN Math N-Q, G-SRT)
- 22) Work in teams to construct a roof frame assembly by implementing required safety techniques, tools, and equipment to accurately measure, lay out, construct, and sheath a roof frame. For example, frame a gable roof with an opening. (TN Reading 3; TN Math N-Q)
- 23) Compare and contrast different procedures to frame a roof. For example, describe the benefits of using prefabricated trusses in place of framing with rafters on site. Outline the major similarities and differences in each and write persuasively to describe why using either prefabricated trusses or framing with rafters is more beneficial for a specific project. (TN Reading 2, 3, 4; TN Writing 1, 4, 7, 9)

Introduction to Building Envelope Systems

- 24) Analyze the components of a building envelope system, including building wrap, insulation, and various types of windows and exterior doors. Describe how the selection and installation of various components affect the energy efficiency of the building, such as the impact of air sealing on energy efficiency. Identify materials and installation strategies used to minimize or prevent air infiltration. For example, explain how the glass type and the proper installation of a window impact the energy efficiency of the building. (TN Reading 2, 4, 5; TN Physical Science 2; TN Physics 2)
- 25) Describe the procedures necessary to prepare a rough opening and install windows and doors. Apply the appropriate tools, equipment, and procedures to prepare rough openings for proper

window and door installation. Properly install a lockset in an exterior door. (TN Reading 3; TN Math N-Q)

Basic Stair Framing Systems

- 26) Analyze the components of a stair system. Read and interpret construction drawings to determine stair system requirements such as the total rise, number and size of risers, and number and size of treads. Based on stated requirements, estimate the amount of material needed to frame a stair assembly. (TN Reading 2, 3, 4, 5, 7; TN Math N-Q)
- 27) Apply the appropriate tools, equipment, and procedures to safely build a small stair unit, demonstrating proper procedures for laying out and cutting stringers, risers, and treads. (TN Reading 3; TN Math N-Q)

Business and Project Management

- 28) Describe strategies used to promote collaboration, trust, and clear communication among internal and external parties on a job site. Practice effective verbal, nonverbal, written, and electronic communication skills for working with colleagues, employers, clients, and other personnel while demonstrating the ability to: listen attentively, speak courteously and respectfully, resolve obstacles in construction, and respond to criticism. For example, assume the roles of a construction business owner and a potential client, listen to the needs of a potential client, and respond to the potential client by email; explain the services provided by the company and the next steps needed to begin the project. Other role playing could include a construction business owner and a potential subcontractor. (TN Reading 2, 3; TN Writing 2, 4)
- 29) Describe the components and purpose of a basic contract document for a residential project. Recognize the relationship and responsibilities of various parties to a contract. Write a basic contract for a construction job, such as a carpenter's contract to complete a deck addition for a residential client. (TN Reading 2, 3, 4, 5)
- 30) Interpret construction drawings to determine the correct materials, tools, and equipment needed to complete a construction project. Plan and implement the steps needed to complete the project, adhering to inspection procedures and employing safe practices throughout. Draw from print and electronic examples to create a materials list, cost estimation, construction schedule, and inspection checklist for a project, applying the components of the documents to the given project. (TN Reading 2, 3; TN Writing 4)
- 31) Log daily activities completed during a construction project over an extended period of time. Document important facts concisely in a daily report as would a project manager on a jobsite, including daily progress, equipment and materials used, personnel involved, and other work-related activities. (TN Reading 3; TN Writing 2, 5, 10)

Portfolio

- 32) Update materials from coursework to add to the portfolio started in *Fundamentals of Construction*. Continually reflect on coursework experiences and revise and refine the career

plan generated in the prior course, using technology where appropriate. Include photographs or illustrations and written descriptions of sequential progress in construction projects. (TN Writing 2, 4, 5, 6)

Standards Alignment Notes

*References to other standards include:

- TN Reading: [Tennessee State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects](#); Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 9-10 Students (page 62).
 - Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standard 10 at the conclusion of the course.
- TN Writing: [Tennessee State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects](#); Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 9-10 Students (pages 64-66).
 - Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standard 3 at the conclusion of the course.
- TN Math: [Tennessee State Standards for Mathematics; Math Standards for High School: Number and Quantity, Geometry](#).
 - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project based activities or collaborate on lesson planning. Students who are engaging in activities listed above should be able to demonstrate quantitative and geometric reasoning as applied to specific technical concepts. In addition, students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.
- TN Physical Science: Tennessee Science: [Physical Science](#) standard 2 may provide additional insight and activities for educators.
- TN Physics: Tennessee Science: [Physics](#) standard 2 may provide additional insight and activities for educators.
- NCCER Curriculum: [National Center for Construction Education and Research](#)
 - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their students will receive a certificate of completion for NCCER Carpentry Level One and be placed in NCCER's National Registry Database.
- P21: Partnership for 21st Century Skills [Framework for 21st Century Learning](#)
 - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.